Applicant respectfully disagrees with the proposition that *Rabinowitz*[1] teaches a motor that can operate in a *steady-state* induction mode. For reasons set forth below, Applicant suggests that the *Rabinowitz* motor is configured to operate in an induction mode for only a limited period. The operation of the *Rabinowitz* motor in an induction mode beyond this limited period will result in overheating and eventual destruction of its rotor.

***Rabinowitz* disclosure**

Rabinowitz teaches a motor having a superconducting material **12** sandwiched between electrical-thermal conductors **12** within a rotor **11**. The rotor **11** is encased by a torque-shield **14**. During a start-up phase, current flowing in stator windings **15** induces current in the torque-shield **14**. In this start-up phase, the motor operates in an induction mode.[2]

As the rotor **11** reaches a desired rotational speed, the magnetic field generated by the stator current extends into the rotor **11** where it is trapped in the superconducting material **12**.[3] The motor then transitions into a steady-state synchronous mode.[4] This feature of the *Rabinowitz* motor enables it to enjoy "improved startup torque while retaining the advantages of synchronous...operation."[5]

In a first embodiment, the motor begins operation with the superconducting material **12** at a temperature already below its critical temperature.[6] In this case, the *Rabinowitz* motor operates in the induction mode until the slip decreases to a preselected value.[7] Once this preselected value is reached, the stator magnetic field is temporarily increased.[8] Driven by this short burst of magnetic field intensity, the traveling electromagnetic field penetrates into the superconducting

[1]*Rabinowitz* et al., U.S. Patent No. 5,325,002 "Trapped Field, Superconducting Induction-Synchronous Motor Generator Having Improved Start-up Torque," filed February 18, 1992 and issued June 28, 1994.
[2]*Rabinowitz*, col. 4, lines 42-45.
[3]*Rabinowitz*, col. 4, lines 51-53.
[4]*Rabinowitz*, col. 4, lines 54-56.
[5]*Rabinowitz*, col. 6, lines 63-65.
[6]*Rabinowitz*, col. 9, lines 4-5.
[7]*Rabinowitz*, col. 9, lines 7-9.
[8]*Rabinowitz*, col. 9, lines 7-9.

material **12**.[9] This field, which becomes trapped within the superconducting material **12**, enables the *Rabinowitz* motor to transition into a steady-state synchronous mode of operation.[10]

In another embodiment, the motor begins operation with the superconducting material at a temperature above its critical temperature.[11] In this case, as the slip decreases, the magnetic field generated by the stator windings diffuses further into the superconducting material **12**.[12] Once this magnetic field has penetrated significantly into the superconducting material **12**, a pump **17** introduces coolant into the rotor **11** through a hollow rotor shaft **18**.[13] This brings the temperature of the superconducting material **12** below its critical temperature and thereby enables the motor to transition into its synchronous mode.

In either case, if the cooling system **16** of the *Rabinowitz* motor were to fail, the temperature of the superconducting material **12** would rise past the critical temperature. The current carried by the superconducting material **12** would then begin to dissipate as heat. To the extent that the electrical-thermal conductors **13** are not in thermal equilibrium with the superconducting material **12**, they can conduct heat away from the superconducting material.[14]

In the meantime, with the superconducting material **12** no longer in its superconducting state, the stator field would then be able to diffuse into the superconductor just as it did during the startup phase of the second embodiment.[15] In doing so, it would induce additional current in the superconducting material **12**, which would then generate additional heat. The electrical-thermal conductors **13** would again conduct this heat away from the superconducting material **12**. However, with nothing draining heat away from the electrical-thermal conductors **13**, they would eventually overheat. This would result in overheating of the superconducting material **12** and eventual destruction of the rotor **11**.

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[9] *Rabinowitz*, col. 9, lines 12-14.
[10] *Rabinowitz*, col. 4, lines 50-56.
[11] *Rabinowitz*, col. 10, lines 1-2.
[12] *Rabinowitz*, col. 10, lines 3-7.
[13] *Rabinowitz*, col. 10, lines 8-11.
[14] *Rabinowitz*, col. 7, lines 1-18.
[15] This is the same effect described in *Rabinowitz*, col. 10, lines 4-11, the difference being that with the cooling system having failed, the temperature of the superconductor cannot be brought back below the critical temperature.

To a limited extent, the interior of the rotor **11** is shielded from the stator field by a torque shield **14** having a thickness in excess of a prescribed skin depth.[16] However, the extent of this protection decreases as the difference between the traveling wave frequency and the rotor's rotational frequency decreases. This is because the skin depth, and hence the extent to which the stator field can reach into and induce current within the rotor **11**, increases as the slip between the stator field and the rotor decreases.[17] These induced currents within the rotor **11**, combined with the absence of any structure for long-term heat dissipation, results in the inevitable overheating of the rotor. As a result, the *Rabinowitz* motor cannot operate in a *steady-state* induction mode.[18]

Applicant's claimed invention

Applicant claims a motor that is operable in a *steady-state* induction mode. As suggested by the specification, "steady-state" refers to an indefinite period of operation.[19] In one embodiment of the invention, namely that described in the specification, the cryostat **12**, the electromagnetic shield **14** and the cold support member **20** are sufficiently massive to enable current to flow without generating excessive heat.[20] In addition, eddy currents flowing in the cold support member **20** can be reduced by providing laminations within the cold support member **20**.[21]

This property of Applicant's claimed motor enables superconducting motors to be used in applications where reliability is paramount. For example, in a cruise ship, a failure of the cooling system of a superconducting motor such as that disclosed in *Rabinowitz* might result in the ship being cast adrift on the open ocean until repairs could be made. This would result in considerable consternation to the passengers.

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[16] *Rabinowitz*, col. 8, lines 49-59.

[17] *Rabinowitz*, col. 5, lines 4-32; There appears, however, to be a missing minus sign preceding the exponent "1/2" in the skin depth formula on line 27.

[18] *Rabinowitz*, col. 8, lines 49-57. *Rabinowitz* refers to the "maximum operable AC loss in the superconductor" as occurring when the slip falls below 5 Hz (by which point the skin depth has risen to 2.9 cm).

[19] *Applicant's specification*, page 10, lines 22-24 "To allow continuous, steady state operation in the induction mode (e.g., until the cooling failure is addressed)..."

[20] *Applicant's specification*, page 10, lines 8-11 and lines 15-18.

[21] *Applicant's specification*, page 11, lines 14-32 and FIG. 4.

In contrast, a superconducting motor according to Applicant's claimed invention would, under similar circumstances, simply transition into induction mode. A ship powered by such a motor could then continue its voyage, albeit at reduced power, even while repairs are being made.[22] On such a ship, the passengers might even be grateful for the extra day or two during which they could enjoy the cruise ship at no additional cost.

In view of the foregoing distinction between applicant's claimed invention and the absence of any teaching of a motor having a steady-state induction mode in *Rabinowitz*, Applicant requests reconsideration and withdrawal of all rejections that rely, in whole or in part, on the proposition that *Rabinowitz* teaches a motor operable in a *steady-state* induction mode.

No additional fees are believed to be due with the filing of this response. However, if additional fees are due, please charge them to Deposit Account No. 06-1050.

Respectfully submitted,

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[22]*Applicant's specification*, page 3, line 28 to page 4, line 7.